

CLAIMS:

1. An apparatus for positioning solder balls in a desired array on a  
5 substrate, comprising a positioning means for positioning the solder balls in  
positions corresponding to the array of positions the solder balls are to take  
up on the substrate, a container for receiving a plurality of solder balls and  
which is movable between a first position remote from the positioning means  
and a second position directly thereover, and means to bias the solder balls in  
10 the direction of movement of the container from the first to the second position  
whereby to reduce or obviate damage to the solder balls during such  
movement.
2. An apparatus according to claim 1, wherein the biasing means  
15 comprises tilting means adapted to rotate the container about an axis  
perpendicular to the direction of motion of the container and thereby tilt it.
3. An apparatus according to claim 2, wherein the container and  
positioning means are rotatable a plurality of times when the container is in  
20 position directly over the positioning means, so that the solder balls are  
repeatedly spread over the positioning means.
4. An apparatus according to claim 2, wherein rotational angles of the  
container and/or the moving speed of the container are controllable to  
25 optimize the efficiency of the apparatus.
5. An apparatus according to claim 3, wherein there is a guide rail and  
motor whereby the motion of the container is guided and driven.
- 30 6. An apparatus according to claim 1, which includes a vibration-  
generating device to facilitate the separation of solder balls from surfaces they  
are in contact with and/or from one another.

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7. An apparatus according to claim 1, wherein the positioning means includes a ball template with a plurality of apertures each slightly larger than the size of a solder ball in order to capture solder balls within the ball template, and wherein the plurality of apertures are arranged in an order similar to the array of positions comprising solder pads on the substrate.
8. An apparatus according to claim 7, wherein solder balls captured in the plurality of apertures are removable by a pick-and-place device while retaining their respective positions, and placed onto corresponding positions of solder pads on the substrate.
9. An apparatus according to claim 7, which includes means to rotate the container, ball template and substrate simultaneously.
10. An apparatus according to claim 7, wherein the apertures comprise through-holes which allow solder balls to fall through the ball template directly onto a substrate placed below it.
11. An apparatus according to claim 7, wherein there is a separator capable of separating the ball template from the substrate in use, and the separator is movable from a first position where passage of solder balls from the ball template onto the substrate is prevented and a second position where passage of the solder balls from the ball template onto the substrate is permitted.
12. An apparatus according to claim 1, wherein the container is closed at the top to reduce oxidation of the solder balls and open at the bottom for direct entry of the balls to the positioning means.
13. A method for positioning solder balls in a desired array on a substrate, comprising providing positioning means for positioning the solder balls in positions corresponding to the array of positions the solder balls are to take up on a substrate, providing a container for receiving a plurality of solder balls, providing means to move the container between a first position remote from

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the positioning means and a second position directly thereover, and providing means to bias the solder balls to move in the direction of movement of the container whereby damage to the spherical objects is reduced or obviated.

- 5 14. A method according to claim 13, wherein the biasing of the solder balls caused by the tilting of the container towards the direction of movement of the container is such that the weight of the solder balls creates a biasing force in the said direction.
- 10 15. A method according to claim 14, wherein the angle of tilting the container and the speed of displacement of the container are controllable in order to optimize the efficiency of positioning the solder balls.
- 16 A method according to claim 13, which includes the step of moving the  
15 container from the second position to the first position while at the same time providing means to bias the solder balls to move in the direction of movement of the container.
17. A method according to claim 16, which includes the step of moving the  
20 container to the location over the positioning means a plurality of times in order to increase the number of solder balls captured by the positioning means.
18. A method according to claim 14, which includes rotating the container a  
25 plurality of times whilst the container is located over the positioning means so that the solder balls are repeatedly spread over the positioning means.
- 19 A method according to claim 13, which includes the step of vibrating  
the container during movement of the container and/or while the container is  
30 located over the positioning means.
20. A method according to claim 13, wherein the positioning means includes a ball template with a plurality of apertures each slightly larger than the size of a solder ball, which plurality of apertures capture solder balls within

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the ball template, and wherein the plurality of apertures are arranged in an order similar to the array of positions comprising solder pads on the substrate.

21. A method according to claim 20, wherein solder balls captured in the plurality of apertures are removed by a pick-and-place device while retaining their respective positions, and placed onto corresponding positions of solder pads on the substrate.

22. A method according to claim 20, wherein the container, ball template and substrate are rotated simultaneously.

23. A method according to claim 20, wherein the apertures comprise through holes which allow solder balls to fall through the ball template directly onto a substrate placed below it.

24. An apparatus according to claim 20, wherein in use a separator separates the ball template from the substrate, and the separator is movable from a first position where passage of solder balls from the ball template onto the substrate is prevented and a second position where passage of the solder balls from the ball template onto the substrate is permitted

25. A substrate on which a plurality of solder balls is arranged in a desired array according to an apparatus according to claim 1, or a method according to claim 13.

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